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Energy Union Factsheet Greece

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Third Report on the State of the Energy Union

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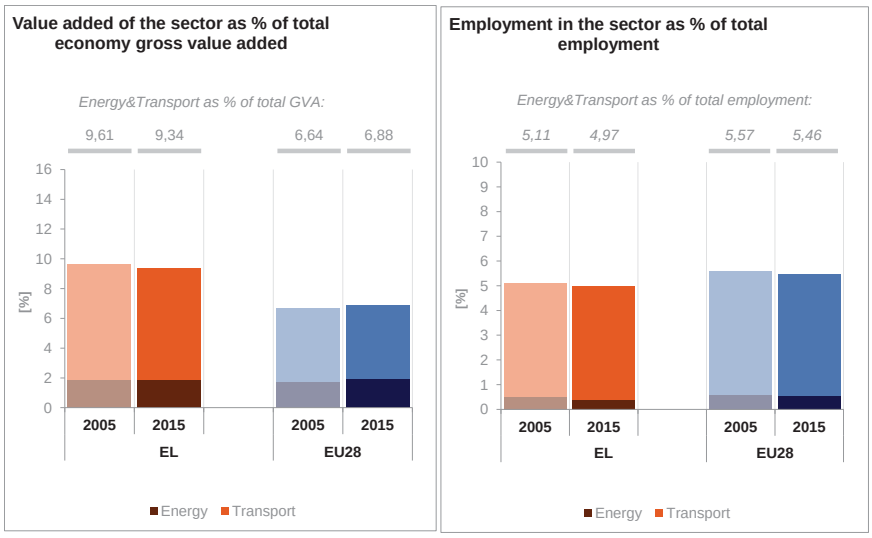
Greece

Energy Union factsheet[1]

1. Macro-economic implications of energy activities

Energy and transport are key sectors for the overall functioning of the economy as they provide an important input and service to the other sectors of the economy. Together the activity in these two sectors[2] accounted for 9.3% of the total value added of Greece in 2015. Similarly, their share in total employment[3] was 5.0% of total employment in 2015, of which 4.6% in the transport sector and 0.4% in the energy sector.



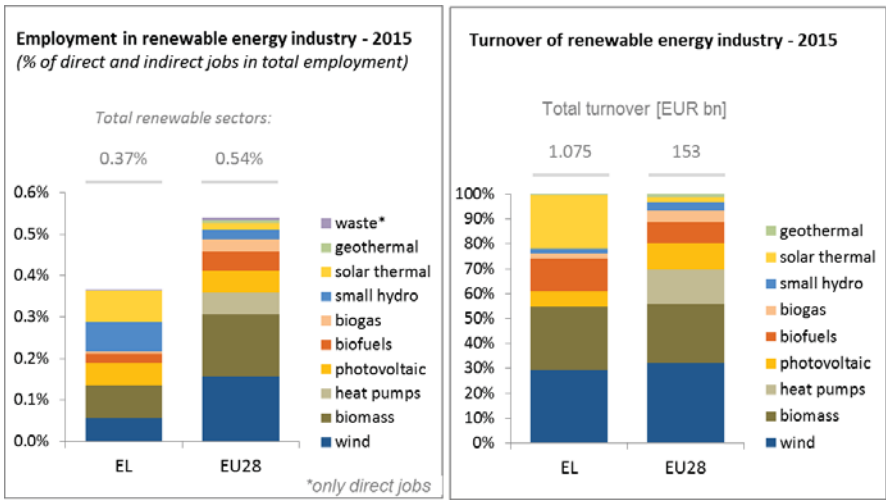
(source: Eurostat)

According to EurObserv'ER, in 2015, the share of direct and indirect renewable energy related employment in total employment of the economy in Greece was at about 0.37%. The turnover of the renewable energy industry in the same year was estimated at around EUR 1.07 billion, more than half being attributed to the biomass and wind (25.5% and 29.3% of total renewable turnover respectively) followed by solar thermal (21.4%) and biofuels industries (13%).

[1] The indicators used in this country factsheet largely build on indicators developed for the Commission Staff Working Document "Monitoring progress towards the Energy Union objectives – key indicators" (SWD(2017) 32 final) https://ec.europa.eu/commission/sites/beta-political/files/swd-energy-union-key-indicators_en.pdf

[2] Gross value added and employment in NACE sectors D-Electricity, gas, steam and air conditioning supply and H-Transportation and storage

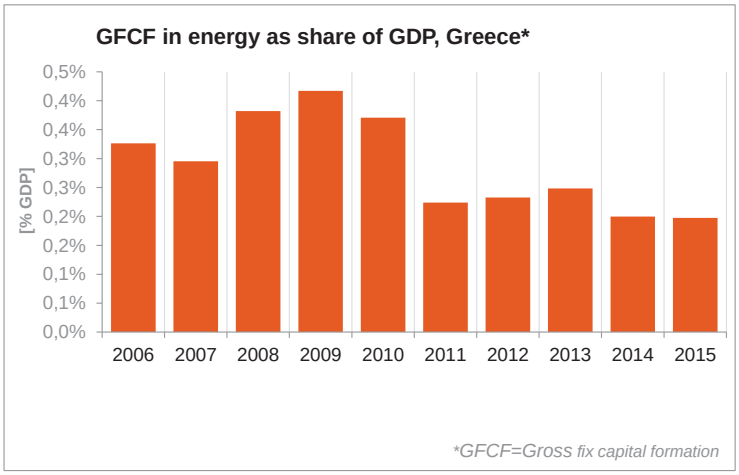
[3] National Accounts, Eurostat



(source: EC based on Eurobserv'Er and Eurostat)

The decarbonisation of the energy and transport sectors will require significant investments and economic activity beyond the remit of these sectors themselves. The energy transition implies a structural shift in economic activity. Energy-related investment and jobs will in part migrate from traditional fossil fuel based activities towards construction, equipment manufacturing and other services related to the deployment of low carbon and clean energy technologies. At the moment, the efforts related to the low-carbon and clean energy transition in sectors beyond energy can only be partially quantified and are therefore not included in this analysis.

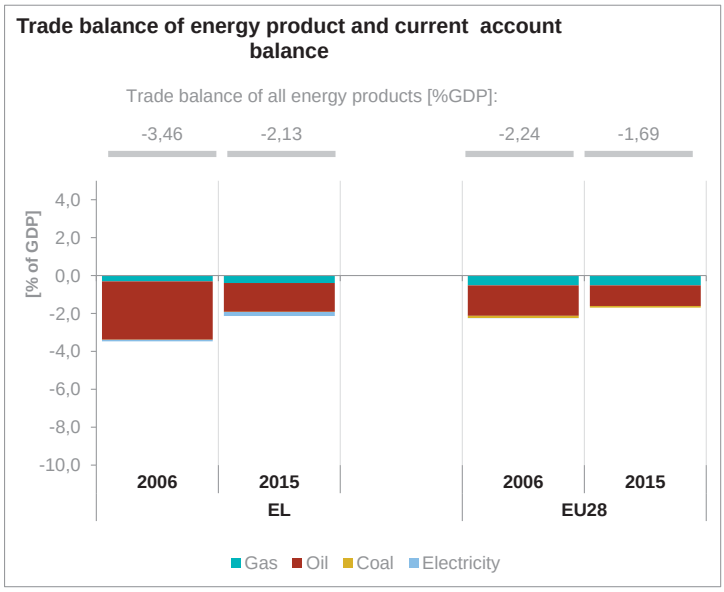
An indication of the level of efforts and challenges encountered by Greece in the energy sector is given by the Gross Fixed Capital Formation (GFCF)[4]. Investments in the electricity and gas sectors, which are taken as reference sectors, have represented around 0.2% of the country's GDP in the period 2011 - 2015, a fall compared to the preceding years where these investments were around 0.4%.



(source: Eurostat)

[4] Gross fixed capital formation consists of resident producers´ acquisitions, less disposals, of fixed tangible or intangible assets. This covers, in particular, machinery and equipment, vehicles, dwellings and other buildings. It also includes foreign direct investment (FDI). Steam and air conditioning supply are also included in the figures mentioned above as Eurostat reports electricity, gas, steam and air conditioning supply together.

In terms of trade, Greece is a net importer of fossil fuels and electricity. The trade deficit in energy products has fallen from about 3.5% of GDP in 2006 to 2.1% in 2015 and has thus become close to the deficit level for the EU as a whole. The decrease is fully accounted for by petroleum products, whereas the numerically much smaller trade deficits for gas and electricity have increased somewhat over time, reflecting the ongoing structural change in Greece's energy mix.

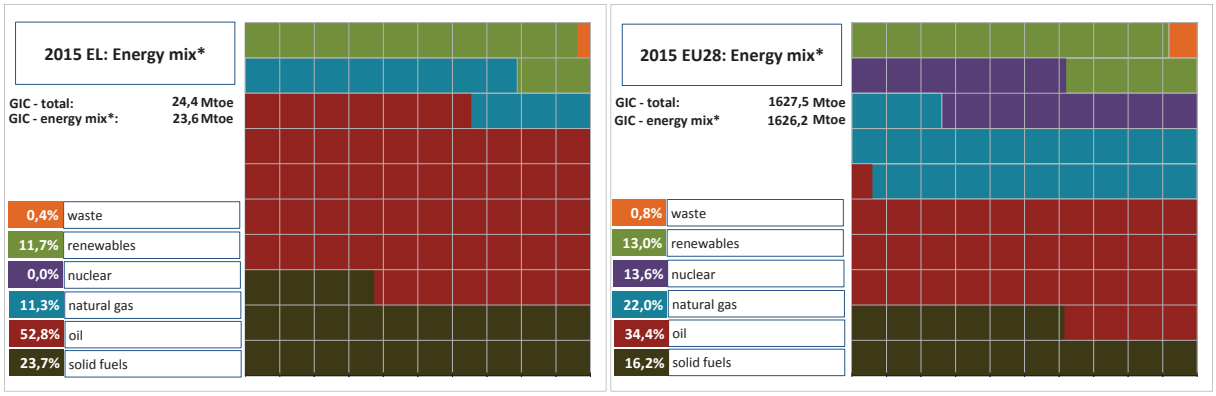


(source: Eurostat)

2. Energy security, solidarity and trust

2.1. Energy Mix

The energy mix of primary products in Greece shows some differences compared to the EU28 average, i.e. by a higher use of petroleum and solid fuels (52.8% and 23.7% respectively versus an EU28 average of 34.4% and 16.2%), while a lower use of natural gas (11.3% versus an EU average of 22%) and no nuclear.

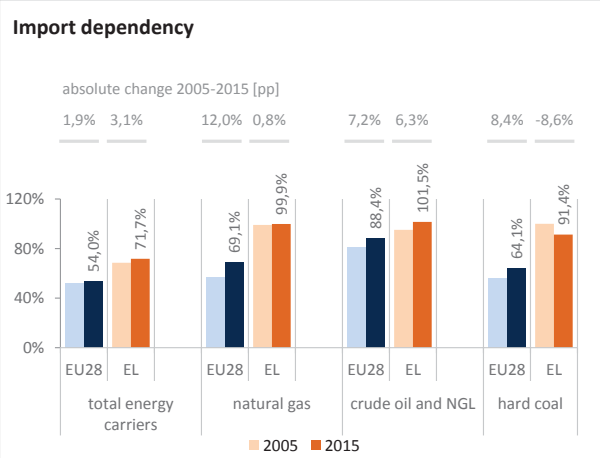


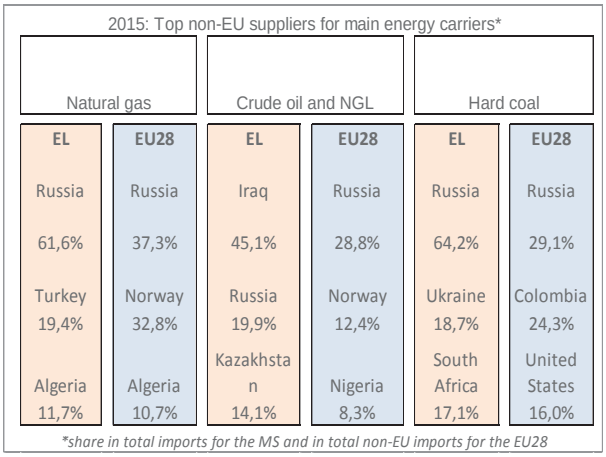
**energy mix as share share in GIC-excluding electricity and derived heat exchanges , GIC=gross inland consumption*

(source: Eurostat)

2.2. Import dependency and security of supply

Import dependency in Greece remains above EU average for all main fossil fuels and in the period 2005 to 2015 increased by 3.3 percentage points, more than the 1.9 percentage points increase observed on average at EU level. When it comes to natural gas and petroleum products, the dependency increased over the same period. In 2015, Greece imported 61.6% of its gas (significantly higher than the average share at the EU level), almost 20% of its crude oil and about 64% of hard coal from Russia.

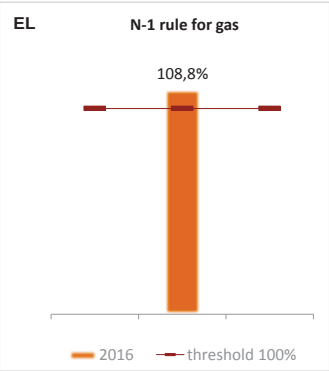




(source: Eurostat)

The importance of security of supply was highlighted in January 2017, when DEPA (the Greek Public Gas Corporation) was forced to make several extraordinary LNG orders to deal with the exceptionally high gas demand --triple the usual amount, and avoid a collapse of the system. The planned construction of the Trans Adriatic Pipeline, as part of the Southern Gas Corridor, is set to significantly improve the diversification of its gas supplies.

From all energy sources, natural gas is the one which generates most concern about security of supply, not least because its important role in the heating of homes and the disruptions experienced in recent years. The security of gas supply regulation requires that, if the single largest gas infrastructure fails in one Member State, the capacity of the remaining infrastructure is able to satisfy total gas demand during a day of exceptionally high gas demand. Greece complies with this rule.

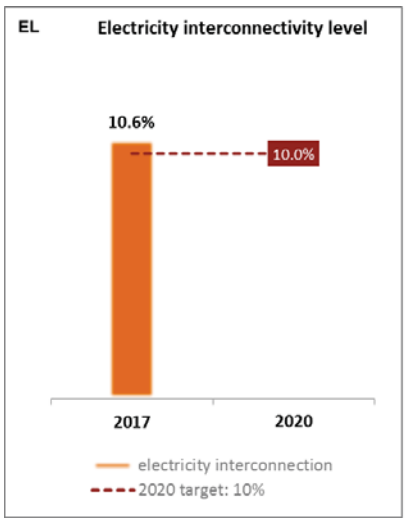


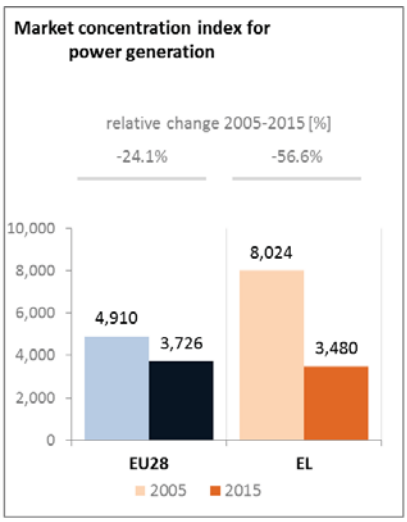
(source: gas coordination group)

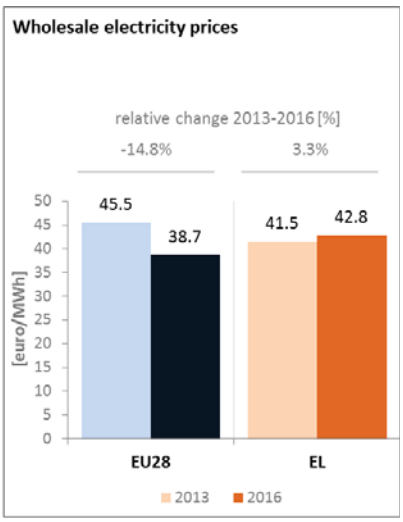
3. Internal market

3.1. Interconnections and wholesale market functioning

3.1.1. Electricity







(source: EC services based on ENTSOE and European power exchanges) *source: EC services based on Eurostat* *source: EC services based on Platts*

The interconnection level[5] for electricity was 10.6% in 2017. The implementation of further electricity-related projects should help Greece to strengthen its interconnections.

Linked to the gas supply crisis mentioned above, the Greek energy system faced significant problems in January 2017 when the country's electricity network nearly collapsed on two occasions and blackouts were averted only at the last minute. The electricity and gas infrastructures found themselves functioning under extreme conditions when demand soared for many days in sub-zero temperatures. The market's failure to reflect the high demand amid energy crisis conditions in natural gas and electricity prices resulted in ruling out imported electricity and at the same time prompted electricity exports to foreign markets.

In terms of market concentration, Greece was among the Member States that saw the most significant decreases in concentration levels (56.6%).

However, there is no true level playing field with the incumbent (PPC) still having a dominant position. The Greek government has committed to reduce the market shares of the incumbent. The already introduced electricity auction will be complemented by structural measures to this effect.

[5] The interconnectivity level is calculated as a ratio between import interconnection and net generation capacities of the country (i.e. the 2017 value is the ratio between simultaneous import interconnection capacity [GW] and net generating capacity [GW] in the country at 11 January 2017, 19:00 pm as resulted from ENTSO-E Winter Outlook 2016/2017).

In Greece, wholesale prices showed a slight increase in the period 2013-2016 (3.3%). Electricity prices were fully liberalised in July 2013 but no effective entry into the market has taken place; the incumbent electricity company remains the dominant supplier as a result.

3.1.2. Gas

Greece was among the numerous Member States that saw an increase of its market concentration for wholesale gas supply (24.5%). This could be presumably driven by a growing reliance on Russian gas.

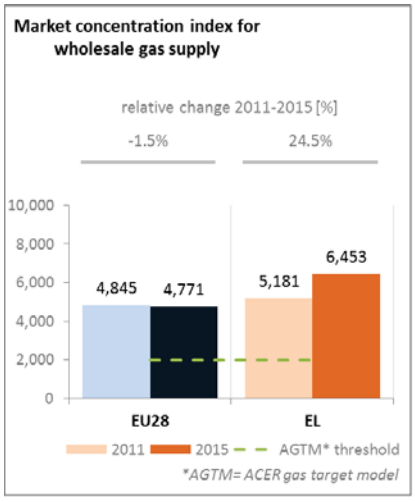
Between 2013 and 2016, Greece was among the Member States that saw the most significant price decreases (-53.9%), placing it below the EU average in 2016. The development of estimated border prices suggests that during 2015 the pricing of Russian gas shifted from oil-indexation towards hub-based pricing.

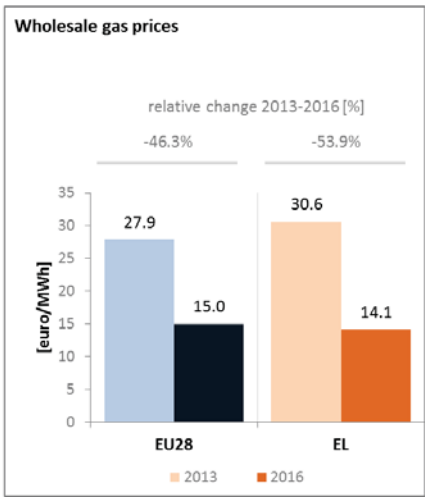
Greece has made significant steps towards a full liberalisation of its gas retail markets. All consumers are now eligible, except households which will become eligible in 2018. The previously existing gas supply monopolies have been abolished and supply and distribution unbundled.

Once implemented fully, this will make it possible for Greek end-consumers to benefit from the increased gas-to-gas competition from LNG and the Trans-Adriatic Pipeline (TAP).

This pipeline is an interconnector (approx. 870 km long) between Komotini in Greece and the region of Puglia in Italy (via Albania). TAP aims at transporting gas produced mainly from the Phase II development of the Shah Deniz field in the territory of the Republic of Azerbaijan. TAP has officially started the construction in May 2016 and is estimated to be completed by 2020.

While an interconnection with Bulgaria through the reverse flow in Kulata-Sidirokastron is possible since mid-2016, several projects are currently planned to further enhance supply opportunities and connections with its direct neighbours. This is most notably the case with: 1) the upgrade of the existing LNG terminal (in the location of Revithoussa, expected to be available in the first half of 2018) and the development of a new one in Alexandroupolis, 2) the Interconnector between Komotini in Greece and Stara Zagora in Bulgaria and, potentially, 3) the IGI Poseidon from Turkey and/or the East-Mediterranean area with the upgrade of the compressor station in Kipi.





(source: ACER for the left graph and EC services based on Platts, gas hubs, Eurostat for the right graph)

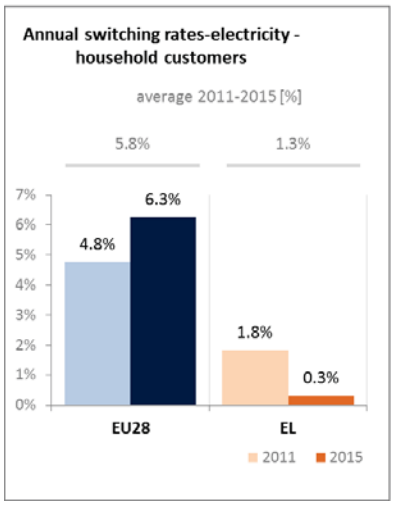
3.2. Retail electricity and gas markets

3.2.1. Electricity

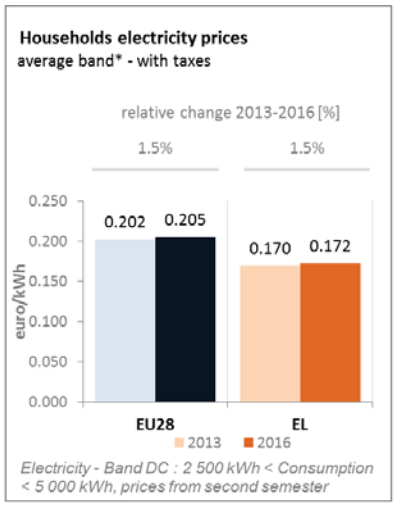
While in 2015 on average 6.3% of household consumers in the EU changed their electricity suppliers, supplier switching in electricity is largely absent in Greece as demonstrated by a declining rate that reached only 0.3% in 2015.

In 2015, households' electricity prices in Greece were below the EU average. Between 2013 and 2016, average band retail electricity prices for households increased by 1.5%.

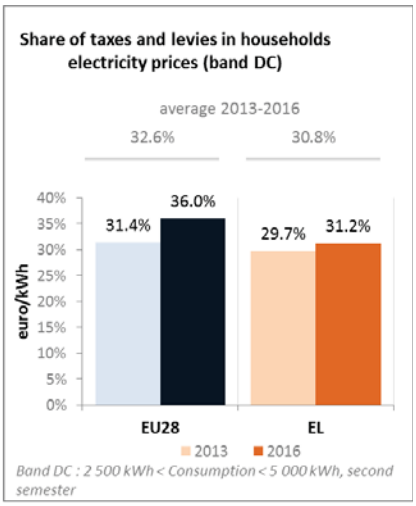
This can be partially explained by an increase in taxes and levies from 29.7% in 2013 to 31.2% in 2016. Retail prices in Greece also include a public service obligation levy to recover the higher cost of power generation in the non-interconnected islands.



(source: ACER)



(source: Eurostat)



(source: Eurostat)

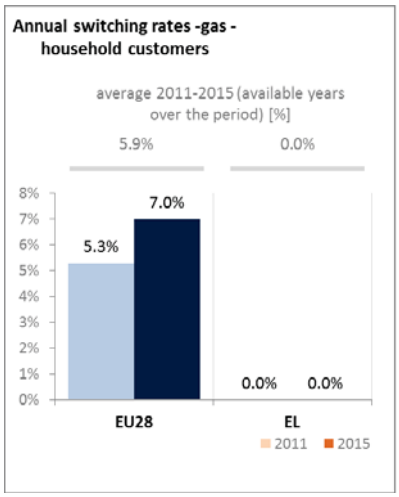
3.2.2. Gas

Greece continues to have a zero switching rate for gas. At present, the gas network is geographically limited; distribution and supply of natural gas to retail consumers is done by three companies (called EPAs) for the regions of Attica, Thessaloniki and Thessalia, and there are no alternative suppliers. DEPA, the incumbent natural gas importer and supplier, supplies natural gas to these three local monopoly distributors. Since the beginning of 2017, only those non-household customers with an annual consumption of greater than 2.2 GWh are eligible to select their supplier of gas in the

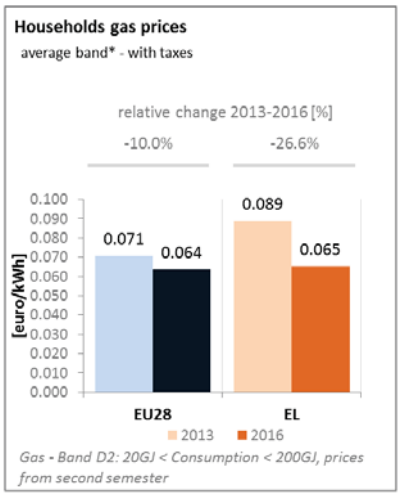
currently EPA-served regions in Greece. As of January 2018[6], all customers, including households, will become eligible irrespectively of consumption level.

Greece was among the limited number of Member States that saw a decrease of its household gas prices by 26.6% between 2013 and 2016, mainly as a result of reduced gas import prices, bringing them very close to the EU average.

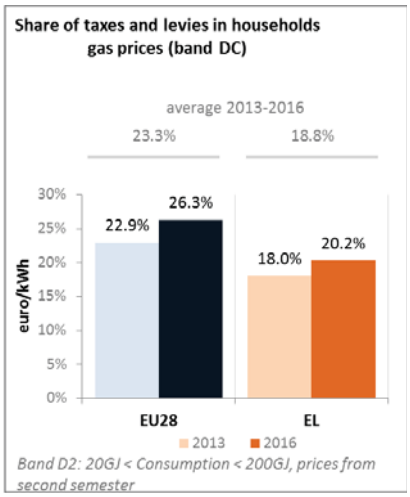
The share of taxes and levies in the retail gas prices paid by household customers is lower than for electricity. While the share showed an upwards trend, reaching 20.2% in 2016, it remained below the EU average by more than 6 percentage points.



(source: ACER)



(source: Eurostat)



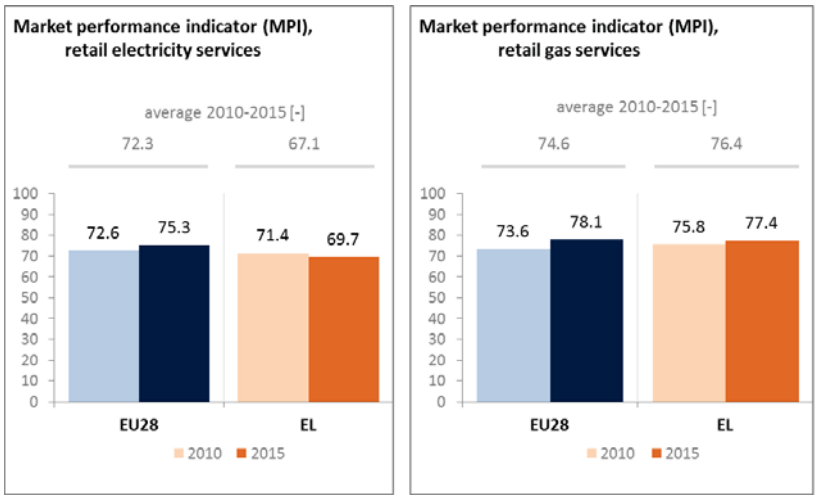
(source: Eurostat)

3.2.3. Market performance indicators

According to the survey of DG JUST, Greek consumers are less satisfied than the EU average about the services received on energy retail markets. Electricity services, despite having improved most (by 5.5 points) since 2013 compared to other services, are in the bottom three markets at national level in terms of performance. Consumer satisfaction related to retail electricity services in fact decreased between 2010 and 2015, further widening the difference with the EU average by more than 5 percentage points.

The opposite trend was observed concerning retail gas services, where consumer satisfaction increased in the period 2010-2015, bringing it much closer to the 2015 EU average. It should be noted that Greek consumer satisfaction for gas was above the EU average in 2010.

[6] According to national law 4001/2011 as amended by law 4336/2015 (FEK A 94/14.08.2015) and law 4337/2015 (FEK A 129/17.10.2015).

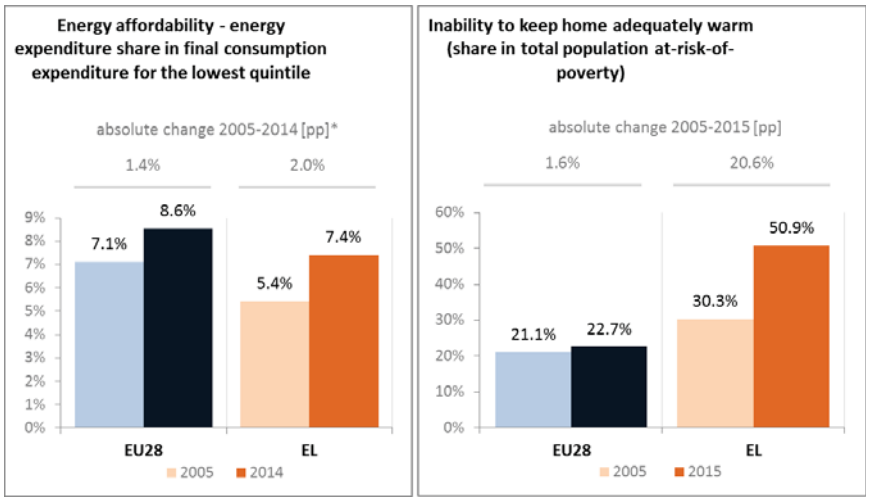


(source: DG JUST survey)

3.3. Energy affordability

In Greece, despite less significant heating needs in comparison with the EU, the share of energy in total household expenditures of the lowest quintile of population is below but close to the EU average. This should be contrasted with the situation in 2005, when the share was lower than the EU average by close to 2 percentage points.

Furthermore, more than half of the most socially deprived householders are unable to keep their homes adequately warm. The share saw a significant increase of more than 22 percentage points in the period 2005-2015 and is more than double the EU average. The impact of the continued economic crisis on household disposable incomes, as also attested by the steadily increasing percentages of the national population (42% in 2015, more than four times the EU-28 average) with arrears on utility bills[7], partly explains these developments. Housing stock issues (poor thermal insulation) could explain the fact that the share was higher than the EU average even before the onset of the economic crisis.



(source: ad-hoc data collection of DG ENER based on HBS with the support of Eurostat and national statistics)

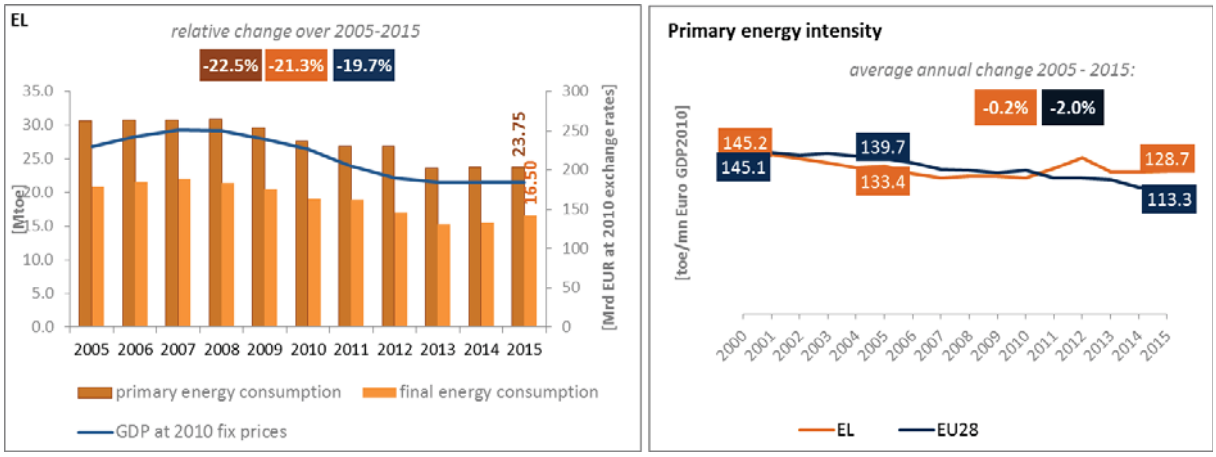
[7] Source: European Commission, based on EUROSTAT SILC survey (EU-Statistics on Income and Living Conditions)

Greece has defined specific criteria and has introduced targeted, protective measures for vulnerable consumers which have been widened since 2014 in order to mitigate energy poverty. Such measures include, amongst others, subsidies for heating oil and electricity and social tariffs. In 2017, 645,262 metering points[8]are under the Social Residential Tariff scheme, an increase of 56% compared to the numbers quoted in 2013[9]. In 2015, Greece also introduced a special measure considering a certain quantity of electricity that is provided for free to residential customers facing severe poverty.

4. Energy efficiency and moderation of demand

Between 2005 and 2015, Greece decreased its primary energy consumption by 22.5% to 23.75 Mtoe. Over the same period, final energy consumption also decreased by 21.3% to 16.5 Mtoe in 2015. Despite the fact that Greece has already achieved levels of primary and final energy consumption below the indicative national 2020 targets (24.7 Mtoe in primary energy consumption and 18.4 Mtoe in final energy consumption), it would need to make an effort to keep the primary energy consumption at this level or to minimise its increase when the GDP grows again during the next five year period.

When describing energy efficiency trends, it is meaningful to compare absolute trends with trends in terms of economic output, not only because energy consumption and economic growth are correlated, but also because a decoupling of these two indicators can be considered as a proxy for increasing energy efficiency. Primary energy intensity in Greece was in 2015 above the EU average, as this indicator decreased more slowly than for the EU average between 2005 and 2015 (0.2% versus a 2% reduction). This could be explained by a more significant decline of GDP as compared to primary energy consumption.

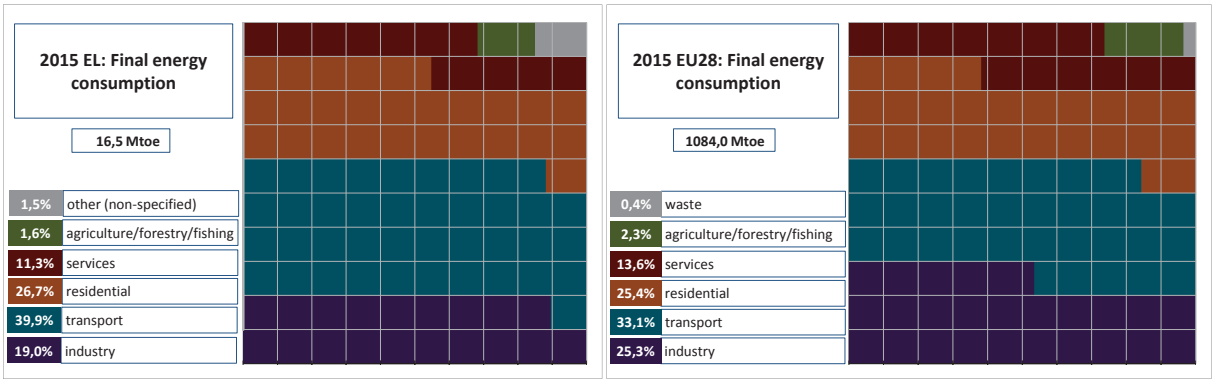


(source: Eurostat)

In 2015, the Greek transport sector was the largest energy consuming sector representing a 39.9% share in the total final energy consumption, which is above the EU average of 33.1%. The energy consumption of Greece's residential sector was in 2015 at 26.7% in total final energy consumption, slightly above the EU average (25.4%). The energy consumption of the Greek industry was lower than

[8]Source: Greek Ministry of Environment & Energy.
[9]Source: RAE 2015 National Report to the European Commission: "At the end of 2014, 522,760 consumers were under the Social Residential Tariff (KOT) scheme (see Table 15), compared to 412,883 consumers, which was the corresponding number at the end of 2013 (an increase of 26.6%)".

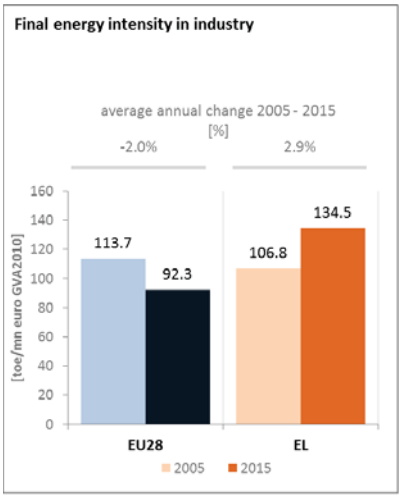
the EU average by more than 6 percentage points, with a share in total final energy consumption of 19%.



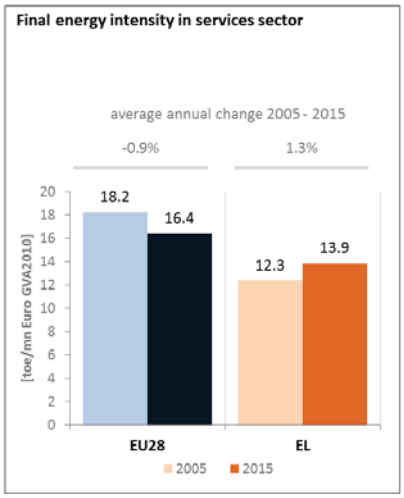
(source: Eurostat)

Whilst influenced by the share of energy-intensive industries, Greece was among the limited number of Member States that saw an increase of the energy intensity in industry over the period 2005-2015. At 131.75, the indicator remained in 2015 significantly above the EU average (92.14).

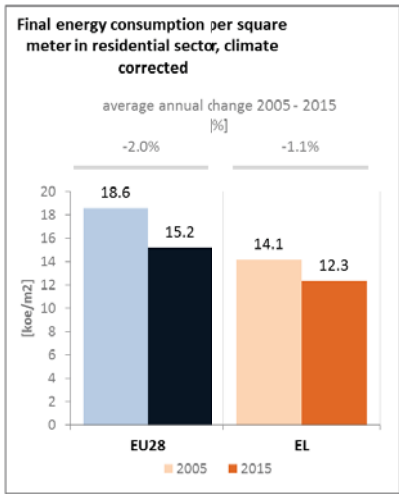
Final energy intensity in the services and residential sector are both below the EU average, with the former running opposite from the decreasing trend of the EU average during the period 2005-2015 while the latter followed the trend of the EU average. Nonetheless, there is still a need to properly implement the national energy efficiency actions and programs in order to meet the cumulative saving requirements stemming from Article 7 of the Energy Efficiency Directive.



(source: Eurostat)

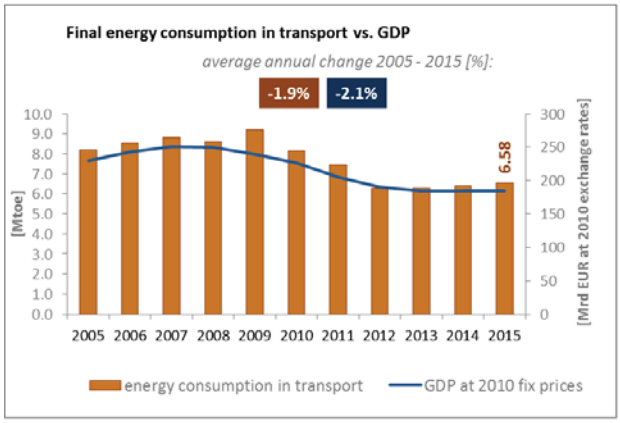


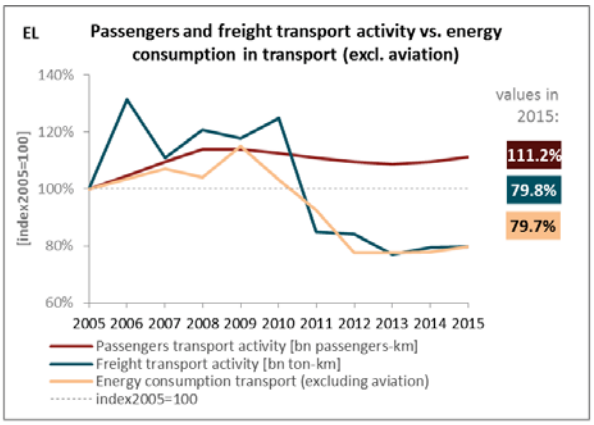
(source: Eurostat)



(source: Odysseedatabase)

For the period 2005-2015, the final energy consumption in Greek transport recorded an average annual decrease of 1.9%, comparable to the 2.1% average annual GDP decrease. This was mostly driven by the significant decrease of freight transport activity observed since the beginning of the economic crisis, compared to the increase in passenger activity over the same period.

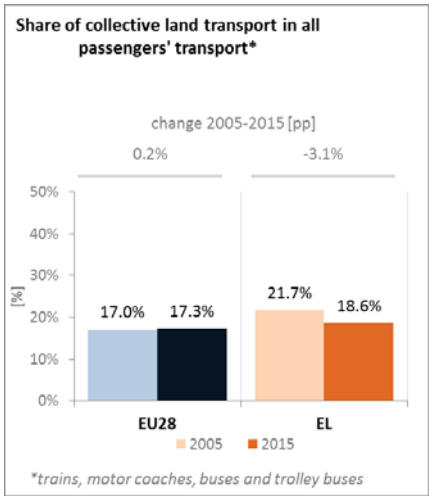




passengers transport activity=Private cars + bus + rail + tram & metro
freight transport activity=road+rail+inland waterways+pipeline

(source: Eurostat) *(source: Eurostatand DG MOVE pocketbook)*

The share of collective passengers land transport into total passengers' transport decreased from 21.7% in 2005 to 18.6% in 2015.



(source: Eurostat)

Greece is making large investments in the railway infrastructure and has several railway projects underway, the most important being the upgrade of Athens-Thessaloniki corridor (to be completed in 2018) and the electrification of Athens-Patra line (up to Eghio, in 2020). As the Patras-Athens-Thessaloniki-Promachonas (northern borders) main corridor is moving gradually closer to completion, new strategic plans are considered for the next generation network expansions (Egnatia Railway, Attica detour etc.).

Greece has been involved in the EU co-funded project "Costa II East - Poseidon Med", which forms part of the TEN-T Priority Project 21, together with Cyprus, Croatia, Italy and Slovenia. COSTA II started in December 2013, and focused on the eastern Mediterranean region/sea in order to prepare a detailed infrastructure development plan promoting the adoption of LNG as marine fuel for shipping operations.

Greece is also active in research and innovation within transport and has participated in a number of Horizon 2020 Transport Research & Innovation projects, such as the E-ferry (electric ferries for

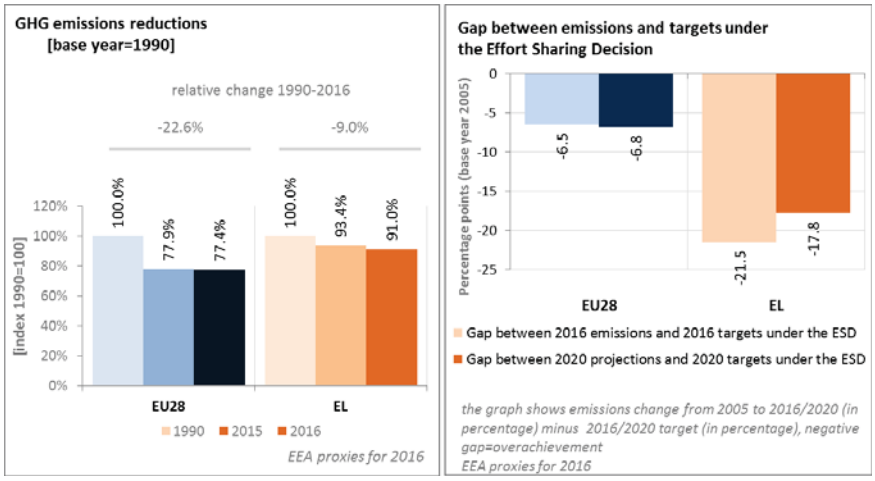
greener water transport) Optimum (developing digital solutions to improve transport mobility in Europe) and SocialCar (a new urban network service, combining public transport with car sharing).

On the use of electric passenger cars, a number of incentives are in place exempting electric and hybrid vehicles from registration taxes, luxury taxes and the luxury living taxes. Cars with engines up to 1929cc are exempted from annual circulation taxes whereas cars with a higher engine capacity pay half of the normal circulation tax rate.

5. Decarbonisation of the economy

5.1. GHG emissions

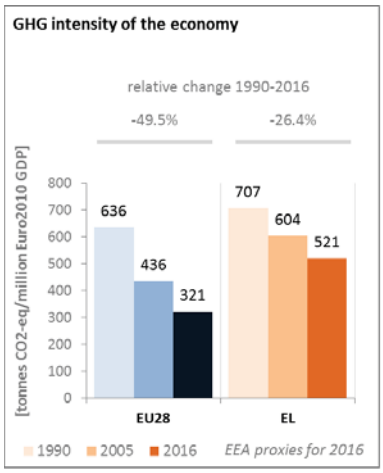
According to the national projections, non-ETS greenhouse gas emissions in Greece will decrease by 22% between 2005 and 2020. Greece will therefore achieve its 2020 greenhouse gas emission reduction target (a 4% reduction in comparison to 2005 emission level).

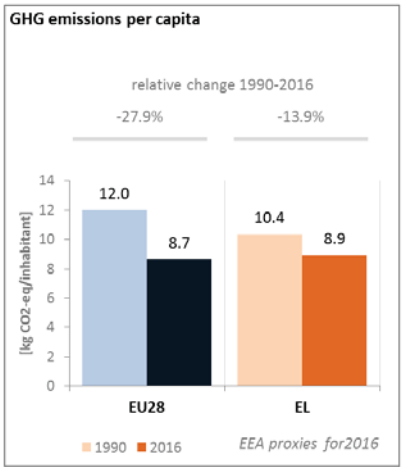


(source: EC and EEA)

According to 2016 EEA estimates, the GHG intensity of Greece's economy was above the EU average, decreasing at half the pace since 1990. In 2016, the GHG emissions per capita in Greece were slightly above the EU average (only 2%); while in 1990 they were below the EU average by 13%.

In 2015, the largest sectors in terms of GHG emissions were the energy sector (43.9 % of total GHG emissions) followed by industry (17.9%), transport (17.9%) and agriculture & fishery (9.3%).



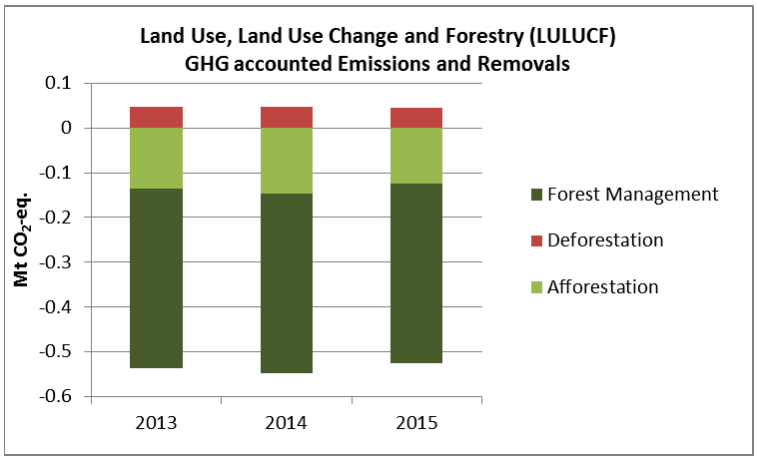


Largest Sectors of GHG Emissions in 2015	EL	EU28
Energy/power industry	43.9%	30.9%
Transport	17.9%	21.0%
Industry	17.9%	19.9%
Agriculture (incl. forestry & fishery)	9.3%	12.0%
Residential & Commercial	6.2%	12.8%
Waste	4.7%	3.2%
Other	0.2%	0.2%

(source: EC and EEA)

Preliminary accounts under the Kyoto Protocol for Greece show overall removals of 0.5 Mt CO_2eq. as an annual average in the period 2013-2015. For comparison, the annual average of the EU-28 accounted for removals of 119.0 Mt CO_2eq. It should be noted that in this preliminary simulated accounting exercise, removals from Forest Management did by far not exceed the accounting cap.

Removals by Afforestation are notably higher than emissions by Deforestation; however, removals by Forest Management contribute the highest share. Overall, there is a no notable trend in removals; only removals by Afforestation show minor variations. Emissions by Deforestation and removals by Forest Management remain constant over the course of the three-year period.

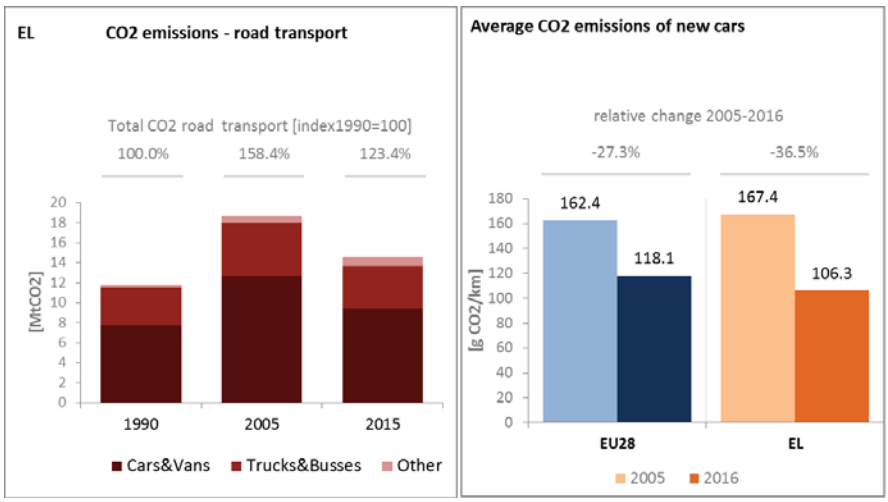


Note: Forest Management credits are capped and presented as yearly averages when the total Forest Management credits of the considered period exceed the simulated cap over the same period.

(source: EC and EEA)

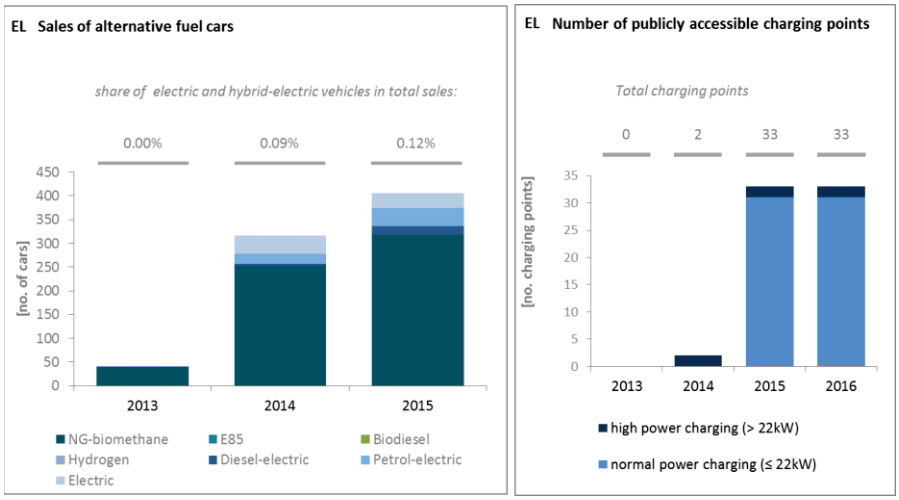
CO_2 emissions in transport and alternative fuelled vehicles

The average CO_2 emissions of new cars in Greece were in 2016 below the EU average and significantly decreased (more than the EU average) between 2005 and 2016.



(source: European Environment Agency)

The number of electric charging points in Greece remained stable to 33 units over the last years according to the EAFO observatory.



(European Environment Agency) *(European Alternative Fuels Observatory)*

National Policy Frameworks under Directive 2014/94/EU on alternative fuels infrastructure have to establish targets, objectives and measures for the development of the market alternative fuels in the transport sector and the deployment of the relevant infrastructure.

To this date, no notification has been received from Greece and the Member State has failed to fulfil its obligations under Article 3(7) of Directive 2014/94/EU.

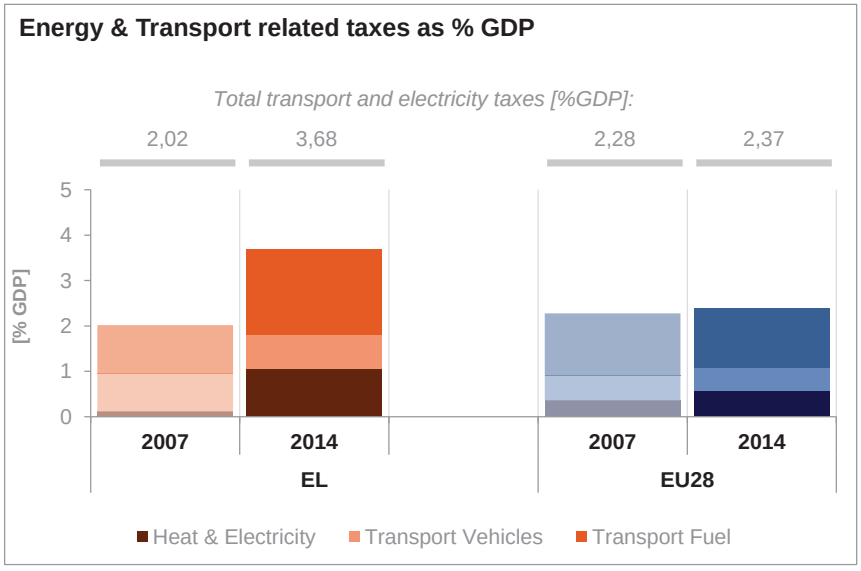
5.2. Adaptation to climate change

Greece published its National Adaptation Strategy in 2016. No specific national, sub-national or sectorial adaptation plans have been adopted so far. The vulnerability assessment of the major sectors in Greece focuses at natural ecosystems and biodiversity, agriculture and food security, forest ecosystems, fisheries and aquaculture, water resources, coastal zones, tourism, human health care,

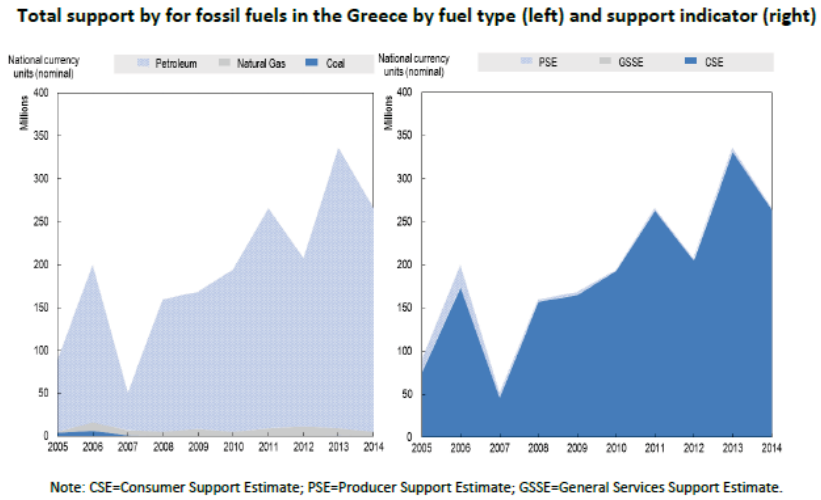
energy, and transport. To date, there is no monitoring of the integration of climate change in sectorial policies, nor is there a framework which assesses adaptation actions that are being implemented.

5.3. Taxes on energy and transport and fossil fuel subsidies

The overall tax burden on energy and transport in relation to GDP has increased strongly in Greece, from 2% of GDP in 2007 to 3.7% in 2014, thus significantly surpassing the EU average (with 1.3 p.p.). The rise in the GDP-share is accounted for by an increase in the tax burden on transport fuels, heat and electricity whereas taxation on transport vehicles has slightly decreased but stayed above the EU average. Greece does not have a carbon tax in place, but the annual tax on car ownership depends on CO2 emission performance.



(Source: Eurostat)

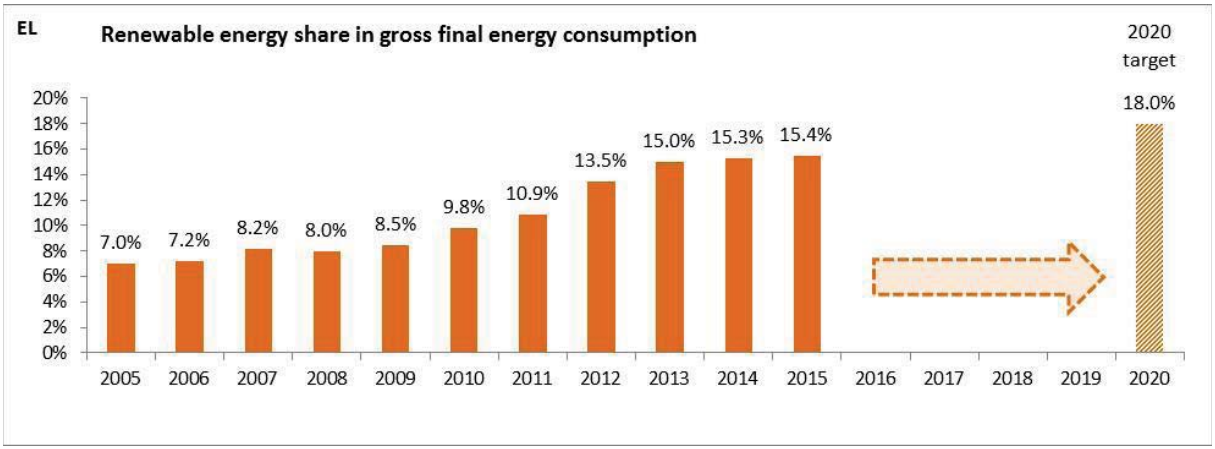


(source: OECD Inventory of Support Measures for Fossil Fuels 2015)

Fossil fuel subsidies have increased sharply in Greece in the last decade. In addition to what is shown in the graph, it can be noted that, following the 2015 Memorandum of Understanding between the European Commission (acting on behalf of the European Stability Mechanism), the Government of Greece, and the Bank of Greece, the country has adopted measures supporting fossil-fuel consumption in certain sectors, such as the preferential tax treatment of diesel fuel used by farmers, and low-income households are granted tax relief for their consumption of heating oil in order to offset income losses.

5.4. Renewable energy

With a 15.4% renewables share in 2015 (against an indicative trajectory of 11.9% for 2015/2016), Greece is on track to meet its 2020 renewables target (18%). In 2015, the share of renewable electricity generation in final electricity consumption stood at 22.1% and in heating and cooling at 25.9%. However, the share of renewables in transport accounted for only 1.4% in 2015, against an objective of 10% by 2020.

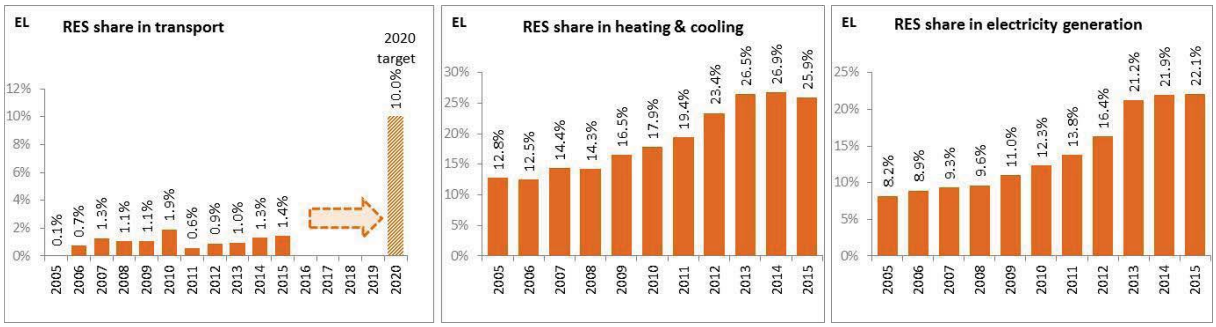


(source: Eurostat-SHARES)

Investments in renewables in Greece have been characterized by a strong growth until 2013, spurred by a generous framework, followed by an abrupt slowdown of investments following the 2014 "New Deal", which imposed significant retroactive/retrospective reductions in the feed-in tariffs for all existing renewable energy projects in exchange for an extension of the duration of their offtake agreements, and set new, reduced FITs for all new RES projects.

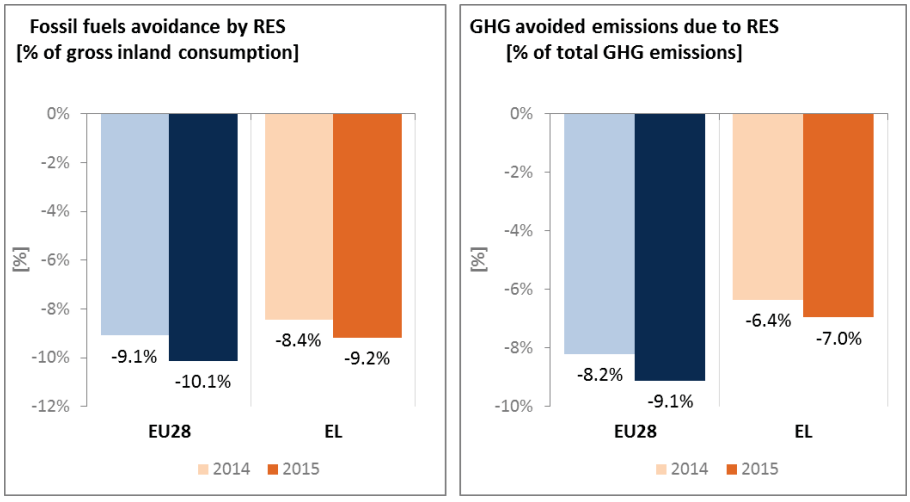
The adoption of Law 4414/2016 in August 2016 has contributed to improving the investment security for new RES projects in Greece. This is something that is generally confirmed by statements from the Greek private sector.

There remain, however, certain uncertainties with regard to the details of the new RES support scheme (including the timing and design of tenders for allocating part of the support) which still have to be defined at the level of the ministerial decisions as well as the amendments of the electricity market and system codes that are foreseen by the law.



(source: Eurostat-SHARES)

Due to a consistent deployment of renewables since 2005, it is estimated that Greece avoided in 2014 about 8.4% of the fossil fuel in gross inland consumption and about 6.2% of GHG emissions at national level[10].



(source: EEA)

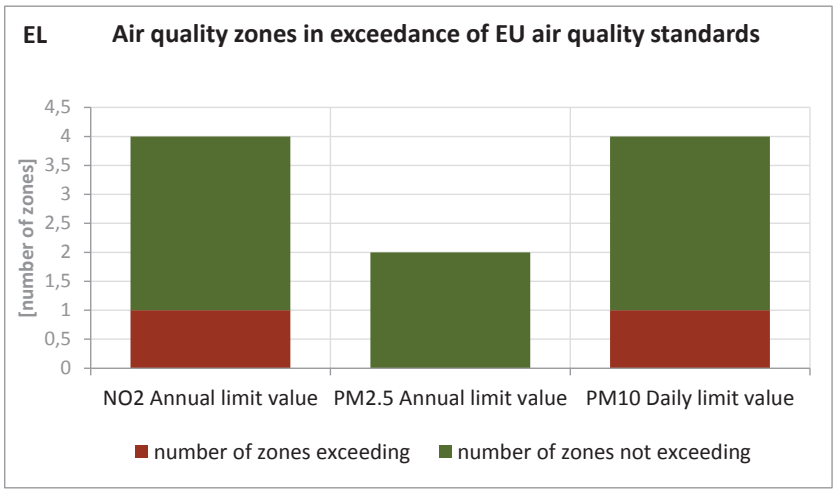
5.4. Contribution of the Energy Union to better air quality

Air quality in Greece continues to give cause for concern. For the year 2013, the European Environment Agency estimated that about 13,730 premature deaths were attributable to fine particulate matter ($PM_{2,5}$) concentrations and 1,490 to nitrogen dioxide (NO_2) concentrations[11].

For both pollutants Greece reported exceedances of the binding EU air quality standards[12]. For the year 2014, Greece reported exceedances of the limit value for PM_{10} and of the limit value for NO_2 in 1 out of the 4 air quality zones in Greece.

[10] Avoided GHG emissions mentioned here have a theoretical character as these contributions do not necessarily represent 'net GHG savings per se' nor are they based on life-cycle assessment or full carbon accounting.

[11] European Environment Agency, 2016, Air Quality in Europe – 2016 Report, table 10.2. The report also includes details as regards the underpinning methodology for calculating premature deaths.



(source: EEA)

The health-related external costs from air pollution in Greece have been estimated to be more than EUR 7 billion/year(income adjusted, 2010), which includes the intrinsic value of living a healthy life without premature death as well as the direct costs to the economy such as healthcare costs and lost working days due to sickness caused by air pollution[13].

The Energy Union can substantially contribute to addressing these air quality problems through measures reducing emissions of both GHG and air pollutants such as PM and nitrogen oxides (NO_x) from major contributing sectors such as (road) transport, energy production, industry and residential heating (e.g. stoves and boilers).

For Greece, no data was reported to indicate $PM_{2.5}$ and $_{NOx}$ emissions by sectors for 2015.

6. Research, innovation and competitiveness

6.1. Research and innovation policy

Support for research, technology and innovation in Greece is based on the National Strategic Development Plan (NSDP). The Plan includes 11 thematic priorities, of which energy is one. At the regional level, the Greek Regional General Secretariats have some freedom to shape priorities for research and innovation (R&I) policy within the general national policy framework.

Energy R&I funding and its thematic priorities are analogous to those of the EU's Framework Programmes on Research: the use of renewable energy sources for electricity, fuels, heating and cooling; hydrogen and fuel cells; clean coal technologies; smart energy networks; and energy efficiency and conservation.

Greece is not a very active contributor to the ongoing work of the Strategic Energy Technology (SET) Plan. Currently, it does not participate in any of the temporary working groups for the implementation of the integrated SET Plan.

[12] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe, OJ L 152, 11.6.2008, p.1-44

[13] See also the EU Environmental Implementation Review Country Report for Greece, SWD(2017)41 final of 3.2.2017

Regarding the Horizon 2020 programme, Greece has received so far 2% of the EU contribution devoted to the 'secure, clean and efficient energy' part of the programme. As of September 2017, 144 participations from Greek organisations have been awarded over EUR 36 million in Horizon 2020 energy projects. This includes a grant of over EUR 1.4 million to the Technological Educational Institute of Piraeus for its participation in project TILOS (battery storage) and six grants totalling over EUR 3.5 million to Greek beneficiaries participating in project WiseGRID (smart grids).

6.2. Investments and patents in the Energy Union R&I priorities

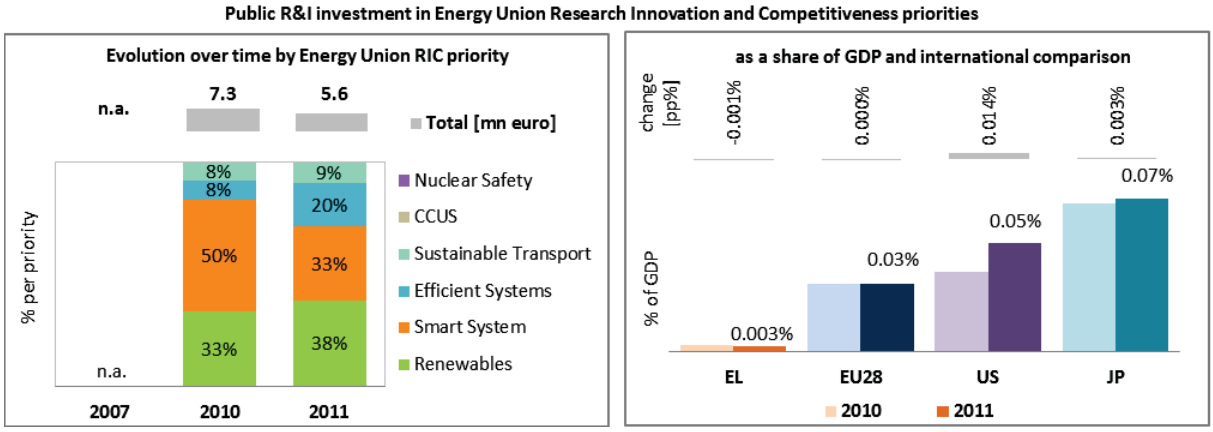
In 2011, the latest year for which data is available, public (national) investments in the Energy Union R&I priorities reached EUR 5.6 million, having decreased by 23% compared to 2010. The highest share of investments (38%) was attracted by the Renewables R&I priority of the Energy Union, followed by the Smart System and Efficient Systems priorities (33 % and 20 %, respectively). The highest public investment was EUR 7.3 million, reported in 2010. For both years, public investment per GDP was lower than the EU average.

Private investment in the Energy Union R&I priorities in 2013 was estimated at EUR 18 million (0.1% of the private R&I investment in Energy Union R&I priorities in the EU). The focus was on the Efficient Systems priority, which received 59% of these investments, followed by Renewables with a share of 36%.

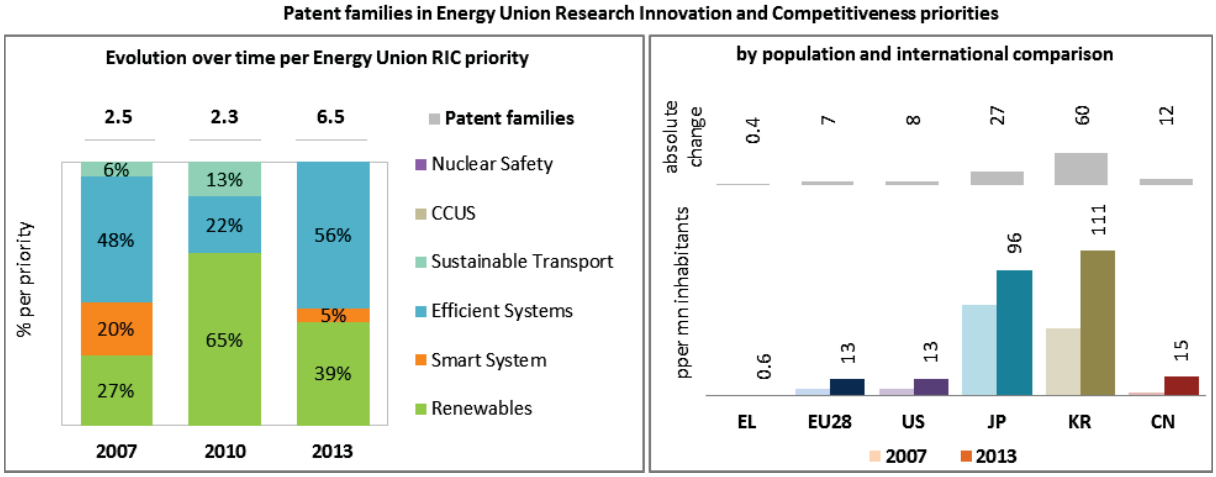
In 2013, the most recent year for which complete patent[14] statistics are available, 8 companies and research organisations based in Greece filed 6 patents in low-carbon energy technologies (0.1% of the EU total). The focus was on Efficient Systems (56%), followed by Renewables (39%) and the Smart System priority (5%).

In 2013, private R&I investments and patents in Energy Union R&I priorities were lower than the EU average when normalised by GDP and by population respectively. In the period 2007-2013, both private R&I investments and the number of patents in Energy Union R&I priorities increased on average by 10% and 17% per year, displaying higher average rates of increase than those at EU level (6% and 15% respectively).

[14] In the context of this document, the term 'patent' refers to patent families, rather than applications, as a measure of innovative activity. Patent families include all documents relevant to a distinct invention (e.g. applications to multiple authorities), thus preventing multiple counting. A fraction of the family is allocated to each applicant and relevant technology.



Note: Data only available for the period 2010 – 2011.



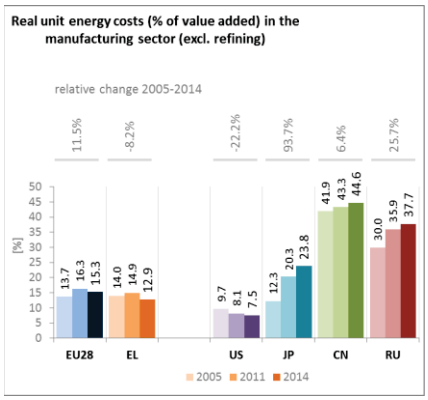
(Data sources: Public investment as available in the International Energy Agency RD&D Statistics database[15] for codes relevant to Energy Union RIC priorities. Patent data based on the European Patent Office PATSTAT database[16]. Private investment as estimated by JRC SETIS. Detailed methodology available from the JRC[17])

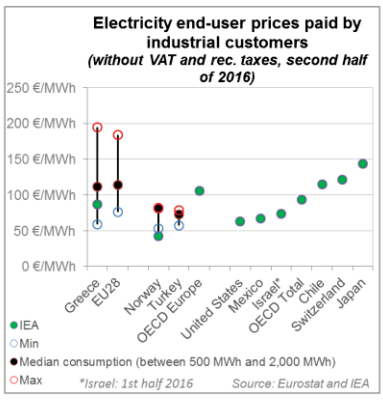
6.3. Competitiveness

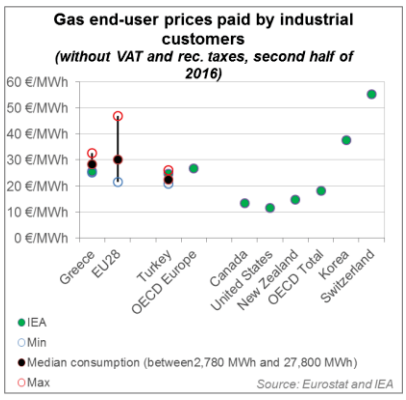
In 2014, the real unit energy costs (RUEC)[18] in Greece were lower than the EU average by more than 2 percentage points and also significantly lower than Japan and China. RUEC has receded after showing an upward trend in 2011, an evolution observed with most EU Member States.

In 2016, the electricity prices paid by the median industrial customer in Greece is on par with the EU average while gas prices for the median industrial consumer is slightly below the EU and OECD averages.

[15] http://www.iea.org/statistics/RDDonlinedataservice/
[16] https://www.epo.org/searching-for-patents/business/patstat.html#tab1
[17] https://setis.ec.europa.eu/related-jrc-activities/jrc-setis-reports/monitoring-ri-low-carbon-energy-technologies
[18] This indicator measures the amount of money spent on energy sources needed to obtain one unit of value added.

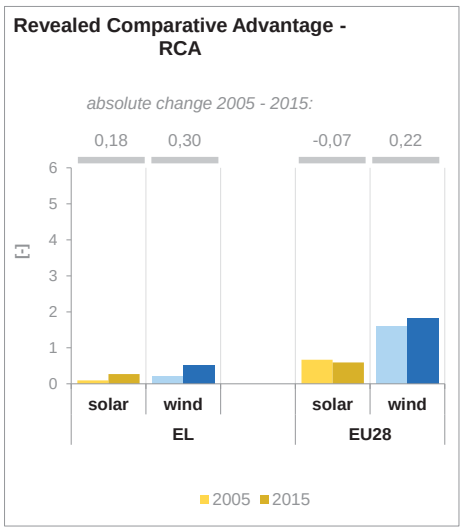


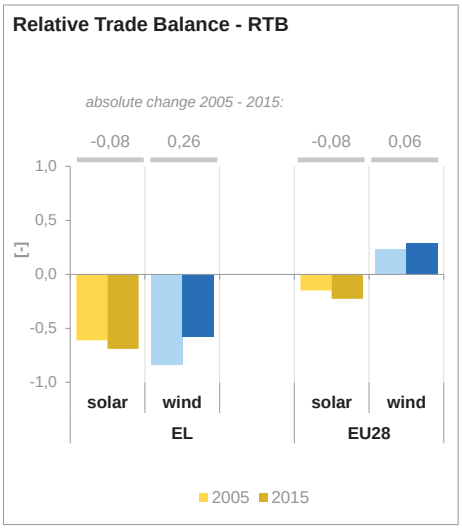




(source: ECFIN) *(source: ESTAT and IEA)*

Greece appears to have had a weak competitiveness performance in wind and solar energy technology, in both absolute terms and vis-à-vis the EU as a whole, although, as regards the latter, the gap has diminished over time. The relative trade balance[19] confirms that Greece is a net importer of solar and wind components, exceeding the EU average, but also here the differences has become somewhat smaller over time. The revealed comparative advantage indicator[20] shows that Greece is not specialised in these technologies while it has expanded in RES generation capacity.





(source: UN comtrade)

7. Regional and local cooperation

Greece is part of the Central and South-Eastern Europe Gas Connectivity (CESEC) High-Level Group, which was established in February 2015 by 15 EU Member States and Energy Community contracting parties and the European Commission, in order to accelerate the integration of Central- and South-Eastern European gas markets and diversify gas supplies, and with the understanding that prioritising

[19] The RTB indicator for product "i" is defined as follows: $RTB_i = \frac{X_i - M_i}{X_i + M_i}$ where X_i is the value of product's "i" exports and M_i imports.2005 refers in the text to the indicator average over the 2000-2009 period, while 2015 represents the average over the 2010-2016 period. The same applies for the RCA indicator - see below.

[20] The RCA index for product "i" is defined as follows: $\mathrm{RCA_i} = \frac{\frac{\mathrm{x_{j,i}}}{\Sigma_i \mathrm{x_{j,i}}}}{\frac{\mathrm{x_{w,i}}}{\Sigma_i \mathrm{x_{w,i}}}}$ where X is the value of exports, and j is the country and w is the reference group, the World economy.

a limited number of the most crucial gas infrastructure projects for the region is the best regional strategy. The aim of the group is to coordinate efforts to facilitate cross-border and trans-European projects that diversify gas supplies to the region, as well as to implement harmonised rules.

The EU macro-regional strategy for the Adriatic and Ionian Region in which Greece takes part can be used as a basis for regional cooperation on energy. European Territorial Cooperation –'Interreg' – under EU cohesion policy also provides further opportunities for cross-border, transnational and interregional cooperation, including in the Energy Union areas.

Cities and urban areas have a key role in the energy and climate challenge. The Urban Agenda for the EU, established by the Pact of Amsterdam in May 2016, better involves cities in the design and implementation of policies, including those related to the Energy Union. It is implemented through Partnerships, in which the Commission, Member States, cities and stakeholders work together on a number of important areas, including on Energy Transition, Urban Mobility, Air Quality, Climate Adaptation and Housing.

By 2016, in the context of the Covenant of Mayors, the sustainable energy action plans delivered by Greek municipalities had been assessed. Overall, these municipalities cover about 4.4 million inhabitants representing close to 40% of the total population in Greece. All together, these municipalities committed to reduce by 2020 the GHG emissions by 23% (as compared to 1990 baseline).

	No. of SEAPs submitted	Population covered by SEAPs [million]	Average GHG emissions [t CO2-eq/capita*year]		Relative GHG savings by 2020
Greece	96	4.43	Baseline emissions 5.18	by 2020 3.99	GHG -23.0%
European Union	5332	160.06	5.50	4.00	-27.2%

(source: JRC 2016. Notes: SEAP=sustainable energy action plan, GHG=greenhouse gas emissions)

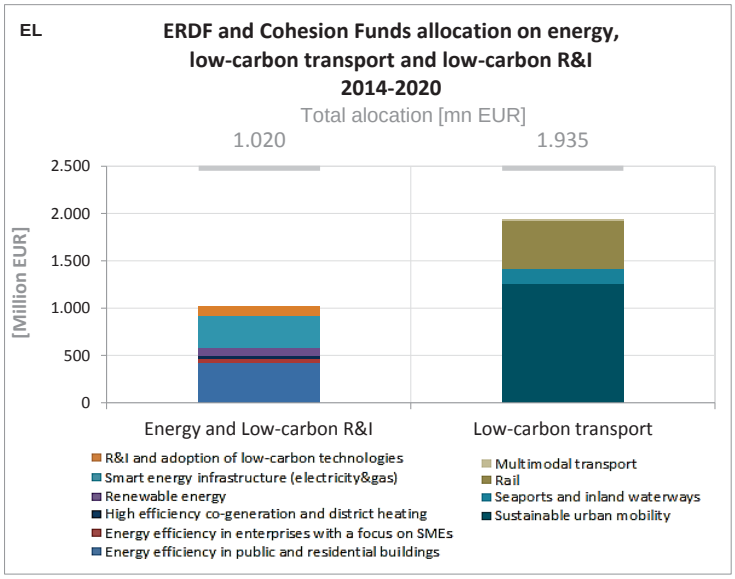
In Greece, by September 2016, 23 cities (covering 1.04 million inhabitants) have committed to conduct vulnerability and risk assessment and develop and implement adaptation plans in the framework of the Covenant of Mayors for Climate and Energy.

8. Cohesion policy and EU clean energy investments

EU cohesion policy makes a key contribution to delivering the Energy Union objectives on the ground, including important investment possibilities to implement energy policy objectives in Greece which are complemented by national public and private co-financing, aiming at optimal leverage. It also ensures integrated territorial solutions to energy and climate challenges, supports capacity building and provides technical assistance.

Over 2014-2020, cohesion policy is investing some EUR 918 million in energy efficiency improvements in public and residential buildings and in SMEs, as well as in high-efficiency cogeneration and district heating, renewable energy and smart energy infrastructure in Greece. Cohesion policy is also investing significantly in R&I and in SME competitiveness in Greece, based on the national strategy for smart specialisation. For Greece, the strategy includes a focus on sustainable energy and low-carbon economy. At this stage, at least EUR 102 million is foreseen for investments in R&I and adoption of low-carbon technologies in Greece but this might increase further in line with the evolving content of the smart specialisation strategy. A further estimated EUR

1,935 million is invested in supporting the move towards an energy-efficient, decarbonised transport sector.



(source: DG REGIO)

These investments are expected to contribute to around 26,000 households with improved energy consumption classification, a decrease of around 97,047,000 kWh per year of primary energy consumption of public buildings, around 170 MW of additional capacity of renewable energy production and 197,000 additional users of smart grids, as well as to around 130 km of new railway lines, 300 km of reconstructed or upgraded railway lines and 40 km of new or improved tram and metro lines. Overall, the EU cohesion policy investments in Greece over 2014-2020 are expected to contribute to an estimated annual decrease of GHG emissions of around 103,000 tonnes of CO2eq.

For example, the LNG terminals in NeaMesimvria (Central Macedonia) and Revythousa (Attica) contribute to energy diversification and security of supply for the country and the South-East Europe. Both projects were co-financed in the period 2007-2013. The NeaMesimvria project increased the capacity of the national gas system by 15.4 MW. The total eligible cost was EUR 57.4 million, of which cohesion policy funding contributed with EUR 17.4 million. The Revythoussa project concerned the second upgrade of the LNG terminal and the construction of a third tank (to be completed in September 2017), aiming to increase the LNG terminal storage and output capacity by 95 000m³, to upgrade the marine facilities to accommodate 85% larger LNG ships and the installation of additional cryogenic equipment aiming to increase the gasification pace by 40%. This project of strategic importance contributes to the flexibility and security in energy supply for the Greek gas transmission system by increasing gas storage capacity by 73%. Moreover, it leads to reduction in LNG prices for the consumers by 4% and also to improved stability of the system in terms of pressure. The total eligible cost was EUR 165.6 million, of which cohesion policy funding contributed with EUR 61 million.

As another example, during the period 2007-2013, EUR 396 million were allocated to the programme Energy Savings at home, out of which EUR 241 million to the Fund EXOIKONOMO (saving at home) to improve energy efficiency in private dwellings. Following the latest data, the outputs achieved to date are as follows: 45 403 dwellings were energy upgraded, allowing savings in primary energy of 64 824.24 tep per year and energy savings in the housing sector of 753.9 GWh, while the cuts in GHG emissions are estimated of 541.3 kt CO2. The Fund EXOIKONOMO has been renewed for the period 2014-2020, foreseeing interventions on the energy efficiency upgrade of households (cohesion policy support EUR 248 million) and to improve energy efficiency in public buildings in the regions (cohesion policy support EUR 44 million).

As a further example, another major breakthrough in the energy sector in Greece is the energy interconnection of the Cyclades Islands with the mainland grid. The project started in the period 2007-2013 and will be completed in the period 2014-2020. The first phase completed during 2007-2013 had a cost of EUR 115.5 million, of with cohesion policy funding contributed with EUR 40.4 million. The completion of this project will allow to stabilise the energy supply to the Cyclades Islands and, at the same time, untap the renewable energy potential of the islands.

Through its support to sustainable transport systems, the Connecting Europe Facility (CEF) also contributes to the goals of the Energy Union. Following Greek participation in the CEF – Transport 2014-2015 Calls, the Greek action portfolio comprises 15 signed grant agreements, allocating EUR 618.1 million of actual CEF Transport Funding to Greek beneficiaries (state-of-play February 2017)[21]. The transport mode which receives the highest share of funding is rail (93.8% of actual funding). The railway actions in Greece concern two main axes: the completion of the Orient East/ Med Corridor according to the Regulation requirements and the railway connection of the node of Thessaloniki with the eastern part of the country along the "Rail Egnatia".

In regards to alternative fuels, the Greek beneficiaries participate in the Maritime Transport mode through the Motorways of the Sea (MoS) actions, aiming to take all the necessary steps towards the adoption of LNG as marine fuel in the East Mediterranean Sea. Moreover, always with the aim to improve the environmental performance of ports and shipping lines, Greek beneficiaries participate to the MoS wider benefit action focussing on the assessment of the possibilities to introduce onshore power supply and electric propulsion alternative (cold ironing) for ships in the Eastern Mediterranean.[22]

[21] Note that European Economic Interest Groups and International Organisations are excluded from the analysis.

[22] Source: INEA